UNCLASSIFIED

2. of C.

FC

INSTITUTE OF INDUSTRIAL RESEARCH

DEPARTMENT OF PHYSICS

Syracuse University

SYRACUSE 10, NEW YORK

MOLECULAR BEAM RADIOFREQUENCY
SPECTRA OF MOLECULES

Chief Investigator: J. W. Trischka
Report for Period

December 1, 1955 May 31, 1956

NR019-606
Contract No. 6N-onr-248
Task Order 11
June 1956

1. Summary

One article has been published and another accepted for publication in the present report period. The new magnet has been completed, tested and installed. Preliminary measurements have been made on the neutral atoms coming from a hot wire bombarded by a molecular beam. Further progress has been made on the theory relating molecular constants measured for various vibrational states to the variation of these quantities with internuclear distance in diatomic molecules.

2. Publications

Dr. Marple's note on our electron multiplier was published in the December issue of the Review of Scientific Instruments. Reprints have been distributed as technical reports for this project.

A long article on the work on Li^6Cl has been accepted for publication by the editor of the Physical Review.

3. C-Magnet

Before assembly the two pole pieces were each tested for flatness with a Sheffield visual guage. The solid face was flat to ± 0.000025 inch and the split pole face was flat to ± 0.000050 inch. Because the surfaces were ground they had a ripple on them and this was estimated to have an amplitude of 0.000025 inch.

After assembly the pole gap was made uniform by means of a saphire ball 0.125 inch in diameter. The ball was a uniform sphere to higher precision than it was possible to adjust the gap. It was discovered that the ball was a very sensitive device for making the gap uniform and the "feel" of its motion in the gap reflected very slight changes in the size of the gap. The mechanical plane parallelism of the gap will determine the uniformity of the electric field, but the uniformity of the magnetic field can be found only by direct measurement as this reflects, in addition, non-uniformities in the material of the pole pieces.

We felt unable to make direct, absolute measurements of the field either with a flip coil or a proton resonance magnetometer. The gap, 0.125 inch, was too small in our opinion to make either method practical. Two relative methods were tried. These methods both made use of another magnet having a large enough gap to make practical the use of a proton resonance magnetometer.

Current Balance: A current carrying wire, suspended from one arm of an analytical balance, was placed in the C-field and the force on the wire balanced by means of weights on a pan suspended from the other arm of the balance. The wire was then balanced in the field of an electromagnet whose field was measured with a proton resonance magnetometer.

This method, which gave a field strength of about 4900 gauss for the C-magnet, was not sufficiently accurate for our purposes. The inaccuracy was a result of inhomogeneities in the field of the electromagnet. The method also had the disadvantage that the wire carrying the current was so long that the field measured was the average of the actual field over a rather large section of the C-magnet.

Hall Effect: The second method made use of the Hall effect in germanium. A small sample of germanium was placed alternately in the C-magnet and in the field of the calibrated electromagnet. This method gave sufficiently accurate results for our purposes. The measurements showed that the field varies along the effective length of the gap (length over which r.f. transitions take place) by about

2 per cent. Data was taken for a large number of points in the field so that the average field over the effective length can be computed. We do not know why the variation in field is so large, but suspect that it is the result of using hardened iron rather than soft iron for the pole pieces. Fortunately, even this large a variation will not prevent us from making significant measurements on the rotational magnetic moments of the molecules.

4. Status of Magnetic Moment Experiment

The C-magnet and other fields have been completely installed and the apparatus is ready for vacuum and electrical testing. A crucial test will be the electrical testing of the C-magnet. It has not been considered safe to test it at high voltages in air, so that these tests will be conducted only when the apparatus is evacuated.

In order to obtain the large r.f. voltages (of the order of 50 v to 100 v) required for this experiment a tuned power amplifier and d.c. power supply for the amplifier have been constructed to amplify the voltage coming from the General Radio oscillator. The amplifier will be manually tuned to give constant r.f. voltage when data is being taken.

5. Surface Ionization Studies

The apparatus for making these studies has been put into operation and some preliminary results have been obtained. The crucial part of the apparatus consists of two tungsten wires which can be flash cleaned, or oxygenated. One wire receives the direct beam of alkali halide molecules from an oven and the second wire accepts only neutral particles given off by the first wire. A beam of KCl is now being used. It has been found that when the first wire is oxygenated about 98 percent of the beam is ionized and 2 percent is given off as neutral atoms or molecules.

A study of the variation of neutrals and ions with temperature shows that neutrals are evaporated in large quantities from the first wire before ionization starts. With the onset of ionization the flux of neutrals starts to decline. There is no way of distinguishing neutral atoms from neutral molecules in this apparatus, so that it cannot be decided whether the neutral particles striking the second wire are atoms or molecules.

6. Variation of Molecular Constants With Internuclear Distance

The formula mentioned in the last progress report has been used in connection with experimental data for the dipole moment of CsF and the results obtained are hard to believe. The formula, which is difficult to derive, was derived twice and is not at present suspect. An examination of the perturbation methods used is being made, and it is hoped that a better understanding of the significance of the formula and its range of application will be obtained.

Some progress has also been made in deriving a new method for obtaining dipole moment information from infrared intensities.

7. Plans

Mr. Russell will continue to work, now full-time, on the magnetic moment experiment and Mr. Kurtz expects to complete his work on the surface ionization studies this summer. I expect to work with both Mr. Russell and Mr. Kurtz and to continue the theoretical work on the variation of molecular constants with internuclear distance.

Respectfully submitted

J. W. Trischka
Project Director